

***Haemaphysalis (Ornithophysalis) phasiana* (Acari: Ixodidae) in the Republic of Korea: Two province records and habitat descriptions**

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Abstract

Tick surveys were conducted during April 2007 in Jeju Province and along the southern coast of Gyeongsangnam and Jeollanam Provinces, Republic of Korea, to assess tick species composition and distribution, and to study tick habitat associations. A total of 58, 19, and 25 sites were surveyed in Jeju, Gyeongsangnam, and Jeollanam Provinces, respectively. Surveys were conducted using tick drags through various vegetative habitats. Habitat descriptions were recorded for each 10-m drag and analyzed to determine habitat associations for each collected species. During this survey, *Haemaphysalis (Ornithophysalis) phasiana* Saito, Hoogstraal and Wassef was collected at 10 sites (144 nymphs) in Jeju Province and at six sites (70 nymphs and 2 females) in Jeollanam Province (new records for both provinces), but was not collected at the 19 survey sites in Gyeongsangnam Province. *Haemaphysalis phasiana* was collected at elevations of 5–245 m and in or near areas that had a marked presence of pine trees as well as dry or green grasses, other herbaceous vegetation, and deciduous understory.

Key words: ticks, Jeju, Jeollanam Province, Gyeongsangnam Province, *Haemaphysalis (Ornithophysalis) phasiana*

Introduction

Haemaphysalis (Ornithophysalis) phasiana Saito, Hoogstraal and Wassef was described in 1974 from collections made on vegetation and green pheasants, *Phasianus versicolor* Vieillot, on Sado Island near Honshu, Japan (Table 1). These authors also examined specimens from China (Yunnan) and Turkmenistan and determined them to be *H. phasiana*. They further suggested a tentative record for Korea based upon their examination of 3 nymphs (HH7121) collected at Chinchup-myeon on 22 August 1965 in Gyeonggi Province during the Migratory Animal Pathological Survey. The nymphs were collected from a chestnut bunting, *Emberiza rutila* Pallas, a common passage migrant during

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Korea's spring and autumn, but they possessed a 2/2 dental formula (most *H. phasiana* nymphs are 3/3) and were "only tentatively considered as *phasiana*" (Saito *et al.* 1974).

Haemaphysalis (Ornithophysalis) phasiana belongs to the *H. (O.) doenitzi* group of species (Hoogstraal & Wassef 1973). The other species in this group are *H. (O.) doenitzi* Warburton & Nuttall, 1909, *H. (O.) hoodi* Warburton & Nuttall, 1909 and *H. (O.) madagascariensis* Colas-Belcour & Millot, 1948. The taxonomic status of the fifth species in the group, *H. (O.) pavlovskyi* Pospelova-Shtrom, 1935 is uncertain. The latter species is considered a junior synonym of *H. (O.) doenitzi* by Camicas *et al.* (1998), but it is treated as a full species by Hoogstraal and Kim (1985) and Filippova (1997). Adults of *H. (O.) phasiana* are readily distinguishable from those of Asian *H. (O.) doenitzi* by their 5/5 dental formula, whereas in *H. (O.) doenitzi* this formula is 4/4. Nymphs of *H. (O.) phasiana* can be discriminated from those of *H. (O.) doenitzi* by their 3/3 dental formula, compared to the 2/2 formula of *H. (O.) doenitzi*. Differentiation of these species in the larval stage has not yet been investigated. From the published descriptions of Hoogstraal and Wassef (1973) and Saito *et al.* (1974), we suspect that both species are polymorphic. We do not exclude the possibility that, within our current concept of species, both may be representatives of a complex or complexes of several closely related species. Consequently, a detailed taxonomic study of *H. (O.) phasiana* and *H. (O.) doenitzi* needs to be undertaken.

Keirans and Robbins (1999) recognized *H. phasiana* as being in Korea based upon Saito *et al.* (1974). However, *H. phasiana* has not been listed in other collective lists of tick species in Korea (Anonymous 1997, Ree 2005), and there are no other reports of this species being established or present in Korea.

Additional literature on this species is scarce and primarily anecdotal. In China, Xu and Luo (1998) reported the collection of one female *H. phasiana* from the barking deer or Chinese muntjac, *Muntiacus reevesi* (Ogilby), in Fujian Province. In Japan, Miyamoto *et al.* (1993) collected one *H. phasiana* nymph from a Middendorff's grasshopper warbler, *Locustella ochotensis* (Middendorff), near Yasugi on 21 September 1991. Kakuda *et al.* (1989) collected *H. phasiana* from Kyushu shika deer, *Cervus nippon* Temminck, on Nozaki Island in the Goto Isles, Nagasaki Prefecture, and from feral domestic rabbits, *Oryctolagus cuniculus* (L.), on Oshima Island of Ushibuka City, Kumamoto Prefecture, Japan. Keirans and Robbins (1999) listed a specimen from the U.S. National Tick Collection (USNTC) as being found in Niigata Prefecture, Sado Island, Kanai, Japan (38° 03'N, 138° 22'E); this is perhaps one of the specimens described in Saito *et al.* (1974). Ishiguro *et al.* (2000) mentioned the collection of one *H. phasiana* as part of their study, but data were not presented in their publication. In Russia, Bolotin (1982) collected one male and one female from a Siberian grey-headed bunting, *Emberiza fucata* Pallas, on 17 July 1979 in Vyazemsky District, Khabarovsk Region, and from a hazel grouse, *Tetrastes bonasia* (L.), in Spassky District, Primorsky Region, on 30 July 1980. Robbins (2005) reported *H. phasiana* from Taiwan based upon 16 collections in the USNTC and from discussion in Saito *et al.* (1974). Finally, the current study reports the collection of substantial numbers of *H. phasiana* in vegetative habitats in Jeju and Jeollanam Provinces in the southern part of the Republic of Korea.

Materials and methods

Tick surveys were conducted from 3 to 10 April 2007 in Jeju Province, and subsequent tick surveys were conducted from 12 to 19 April 2007 along the southern coast of Gyeongsangnam and Jeollanam Provinces. The objectives of these surveys were to assess tick species composition and distribution and to study habitat associations of early-season tick species.

TABLE 1. Collection data for *Haemaphysalis phasiana* from published literature.

Data Source ¹	Date Collected	Country	Host/Habitat	Locality ^{1,2}	Tick Sex/Stage
Saito <i>et al.</i> 1974	9 Jul 1972	Japan	Vegetation	Kanai, Sado Island	8 M, 10 F, 18 N
Saito <i>et al.</i> 1974	29 Jun 1972	Japan	Vegetation	Kanai, Sado Island	2 M, 1 F, 28 N
Saito <i>et al.</i> 1974	22 Apr-11 May 1972	Japan	Vegetation	Kanai, Sado Island	14 N
Saito <i>et al.</i> 1974	18 Aug 1972	Japan	Vegetation	Kanai, Sado Island	1 F
Saito <i>et al.</i> 1974	Jun 1957/1972	Japan	Vegetation	Umezu, Sado Island	1 M, 1 N
Saito <i>et al.</i> 1974	28 Jun 1972	Japan	Vegetation	Kawasaki, Kanagawa	1 F
Saito <i>et al.</i> 1974	17 Sep 1956	Japan	<i>Phasianus versicolor</i> Vieillot	Green pheasant, Shukunegi (total from 4 hosts)	18 M, 1 F, 33 N, 74 L
Saito <i>et al.</i> 1974	Nov 1958	Japan	<i>Phasianus versicolor</i> Vieillot	Green pheasant, Umezu, Haguro, and Utashiro (Sado Island)	3 F, 5 N, 42 L
Saito <i>et al.</i> 1974	10 Jan 1956	Japan		Akune, Kagoshima Prefecture, Kyushu Island	1 F
Saito <i>et al.</i> 1974	1891	Japan		Holst (specimen in British Museum Natural History 1891.11.15)	1 F
Saito <i>et al.</i> 1974	29 May 1966	Japan	<i>Turnix suscitator blakistoni</i> (Swinhoe)	Barred buttonquail, Miyako Jima, Ryukyu	1 N
Miyamoto <i>et al.</i> 1993	21 Sep 1991	Japan	<i>Locustella ochotensis</i> (Middendorff)	Middendorff's grasshopper warbler, Yasugi	1 N
Kakuda <i>et al.</i> 1989	1982-1988	Japan	<i>Cervus nippon</i> Temminck	Kyushu shika deer, Nozaki Island, Goto Isles, Nagasaki Prefecture	1 N
			<i>Oryctolagus cuniculus</i> (L).	Feral domestic rabbits, Oshima Island, Ushibuka City, Kumamoto Prefecture	3 F
Saito <i>et al.</i> 1974	22 Aug 1965	Korea	<i>Emberiza rutila</i> Pallas	Chestnut bunting, Gyeonggi Province (Migratory Animal Pathological Survey, HH7121)	3 N
Saito <i>et al.</i> 1974	19 Aug 1945	China	<i>Monticola solitarius pandoo</i> (Sykes)	Blue rock thrush, Yunnan (HH41,608, RML 22,683)	1 M
Xu & Luo 1998	Mar 1997-Feb 1998	China	<i>Muntiacus reevesi</i> (Ogilby)	Barking deer or Chinese muntjac, Fujian Province	1 F
Bolotin 1982	17 Jul 1979	Russia	<i>Emberiza fucata</i> Pallas	Siberian grey-headed bunting, Vyazensky District, Khabarovsk Region	1 M
Robbins 2005	30 Jul 1980	Russia Taiwan	<i>Tetrastes bonasia</i> (L.)	Hazel grouse, Spassky District, Primorsky Region 16 Taiwan collections in the U.S. National Tick Collection	1 F
Saito <i>et al.</i> 1974	?	Turkmenistan	<i>Phasianus colchicus</i> L.	Ringed-necked pheasant, (HH40,780)	1 M

¹HH=Harry Hoogstraal (now USNTC); RML=Rocky Mountain Laboratories (now USNTC).

²All communities on Sado Island merged into the municipality of Sado City on 1 March 2004.

Surveys were conducted using tick drags (approximately 1m wide x 1m long) through various vegetative habitats. Survey personnel checked and recorded the number of ticks after dragging for approximately 10-meter intervals through selected habitats. Ticks collected after each 10-meter interval were placed into a single vial and labeled (date, location, brief habitat description, and drag sequence number). Additionally, photographs of each survey site were taken and maintained on an electronic data sheet that included the location (grid coordinates), habitat description, vial number, number of ticks/vial and species determination. Ticks were microscopically examined in a laboratory setting, and those tentatively identified as *H. phasiana* were sent to the USNTC for confirmation.

Results

A total of 58, 19, and 25 sites were surveyed on Jeju and in Gyeongsangnam and Jeollanam Provinces, respectively. During these surveys, *H. phasiana* was collected at 10 sites (144 nymphs) in Jeju Province and at 6 sites (70 nymphs, 2 females) in Jeollanam Province (Table 2). *Haemaphysalis phasiana* was not collected at the 19 survey sites in Gyeongsangnam Province. The sites in Jeju Province were distributed around the perimeter of the island at elevations ranging from 29 to 245 m. The *H. phasiana* positive sites in Jeollanam Province were located in the southwest corner of the province at elevations ranging from 5 to 111 m.

Jeju Province. Of the 10 collection sites in Jeju Province where *H. phasiana* was found (Figure 1), *Haemaphysalis longicornis* Neumann was collected at 8 sites, *Haemaphysalis flava* Neumann was collected at 7, and *Ixodes turdus* Nakatsudi was collected at 4 sites. *Haemaphysalis phasiana* was collected on 68 of 1251 drag sequences (10 m intervals), and was collected with *H. longicornis*, *H. flava*, and *I. turdus* on 21, 13, and 7%, respectively, of these 68 drags; *H. phasiana* was collected by itself on 43 (63%) of the drags.

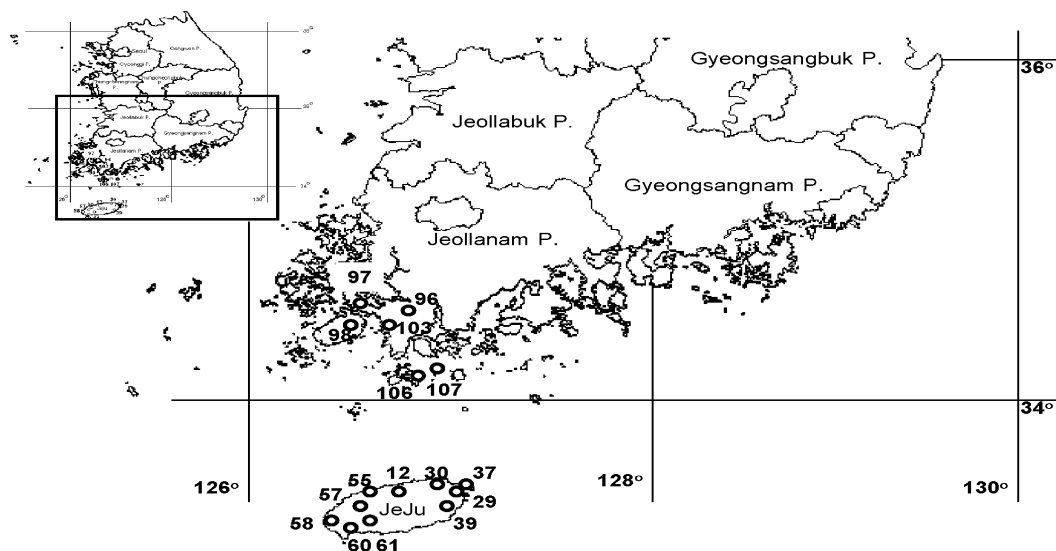


FIGURE 1. Collection sites for *Haemaphysalis phasiana* in southern Republic of Korea.

In Jeju Province, *H. phasiana* showed a very strong affinity for areas that contained pine trees, *Pinus densiflora* Siebold and Zuccarini. Forests that were almost exclusively pine accounted for

TABLE 2. Collection data for *Haemaphysalis phasiana* collected in Jeju and Jeollanam Provinces, Republic of Korea.

Site	Date	Grid Coordinates, Elevation	Locality	# Ticks
KOR07-012	3-Apr-07	33° 31' 07.07" N, 126° 32' 45.85" E, elev. 123m	Sarabong, Jeju-si, Jeju Province	62
KOR07-029	5-Apr-07	33° 29' 49.45" N, 126° 54' 12.60" E, elev. 29m	Jongdal-ri, Gujwa-eup, BukJeju-gun, Jeju Province	4
KOR07-030	5-Apr-07	33° 32' 07.51" N, 126° 46' 19.34" E, elev. 92m	Maze Park, 5km SW of Woljeong, Jeju Province	8
KOR07-037	6-Apr-07	33° 29' 54.46" N, 126° 57' 49.54" E, elev. 62m	SE side of Cow Island (U-do), Jeju Province	11
KOR07-039	6-Apr-07	33° 24' 43.60" N, 126° 50' 37.43" E, elev. 145m	Yukeonae Oreum (Mt.), Seongsan-eup, NamJeju-gun, Jeju Province	27
KOR07-055	8-Apr-07	33° 27' 18.65" N, 126° 20' 35.59" E, elev. 105m	Gonaesan (Mt.), Haga-ri, Aewol-eup, BukJeju-gun, Jeju Province	13
KOR07-057	8-Apr-07	33° 22' 29.64" N, 126° 17' 28.03" E, elev. 210m	Dongmyeong-ri, Hallim-eup, BukJeju-gun, Jeju Province	5
KOR07-058	8-Apr-07	33° 20' 02.83" N, 126° 14' 55.36" E, elev. 189m	Jeoji-oreum, Hangeong-myeon, BukJeju-gun, Jeju Province	5
KOR07-060	8-Apr-07	33° 14' 22.63" N, 126° 15' 57.89" E, elev. 66m	Moseulbong (hill), Daejeong, Daejeong-eup, NamJeju-gun, Jeju Province	8
KOR07-061	8-Apr-07	33° 17' 13.56" N, 126° 19' 02.68" E, elev. 245m	Seogwang-ri, Andeok-myeon, NamJeju-gun, Jeju Province	1
KOR07-096	17-Apr-07	34° 35' 05.28" N, 126° 33' 44.14" E, elev. 21m	Sandeung, Haenam-gun, Jeollanam Province	1
KOR07-097	17-Apr-07	34° 34' 11.78" N, 126° 22' 21.47" E, elev. 28m	Okdong, Haenam-gun, Jeollanam Province	1
KOR07-098	17-Apr-07	34° 33' 56.59" N, 126° 18' 10.66" E, elev. 111m	Nokjin, Jindo-gun, Jeollanam Province	21
KOR07-103	18-Apr-07	34° 30' 26.32" N, 126° 28' 49.94" E, elev. 30m	Yuldong, Haenam-gun, Jeollanam Province	1
KOR07-106	18-Apr-07	34° 21' 30.38" N, 126° 44' 04.60" E, elev. 5m	Chang Island ¹ (Cheonghaejinyujeok), Wando-gun, Jeollanam Province	43
KOR07-107	19-Apr-07	34° 20' 38.94" N, 126° 53' 42.11" E, elev. 8m	Donggo, Sinjido, Wando-gun, Jeollanam Province	3

¹Two female *Haemaphysalis phasiana* were collected at this site; all other collections were nymphs.

79% of the total collections, while forests that contained a mix of pine and oriental arborvitae, *Platycladus orientalis* (L.) Franco, accounted for an additional 9% of the collections. The remaining 12% were collected in grassy edge habitats bordering pine or pine/oriental arborvitae mixed forests. *Haemaphysalis phasiana* was not collected in forests that were predominantly deciduous trees; however, deciduous understory and shrubs were noted during 34% of the collections. Pine, oriental arborvitae, and deciduous leaf litter (from understory in pine-dominant forests) were noted during 88, 9, and 16% of the drags, respectively.

Forty-four percent of the *H. phasiana* collections were made in deeply shaded pine forests, 44% in partially shaded pine forests, and 12% in open areas along the edge of pine forests. Dry grass, green grass, and green herbaceous plants were noted during 35, 25, and 79% of the collections, respectively. Ferns were noted during 12% of the collections, and ivy emerging through leaf litter was noted during 6% of the collections. One Jeju site, which represented 32% of the *H. phasiana* positive drags (43% of *H. phasiana* collected) was in a designated public park.

Jeollanam Province. Of the 6 collection sites in Jeollanam Province where *H. phasiana* was found (Figure 1), *H. longicornis* was collected at all 6 sites, *H. flava* was collected at 5, and *Ixodes nipponensis* Kitaoka and Saito was collected at 2. *Haemaphysalis phasiana* was collected on 22 of 1070 drag sequences, and was collected with *H. longicornis* and *H. flava* on 41 and 9%, respectively, of these drags; *H. phasiana* was collected by itself on 13 (59%) of the drags. Even though *I. nipponensis* was collected at two of the sites where *H. phasiana* was collected, it was not collected simultaneously with *H. phasiana* on the same drag sequence. *Amblyomma testudinarium* Koch was also collected during this survey, but not at any of the *H. phasiana* positive sites.

In Jeollanam Province, *H. phasiana* showed a strong affinity for areas that contained pine but also showed a strong affinity for open grassy areas. Forests that were predominately pine accounted for 36% of the total collections, while forests that contained a mix of pine and deciduous trees accounted for 18% of the collections. Nine percent of the *H. phasiana* collections were made in the grassy edge habitats bordering pine or pine/deciduous mixed forests, and the remaining 36% were collected in the mowed grasslands of a public park. These latter collections were 50-75 m from the edge of pine habitat but were considered to be separate from those associated with pine forests. One *H. phasiana* was collected in a forest that contained more deciduous than pine trees, and deciduous understory was noted during 50% of the collections. Pine and deciduous leaf litter were noted during 55 and 50% of the drag sequences, respectively.

Fifty-five percent of the *H. phasiana* collections were made in shaded to partially shaded habitats, and 45% were made in open areas. Dry grass, green grass, and green herbaceous plants were noted during 50, 45, and 41% of the collections, respectively. One Jeollanam site, which represented 45% of the *H. phasiana* positive drags (62.5% of ticks collected), was in a designated public park.

Discussion

The collections of *H. phasiana* reported herein confirm the presence of this species in the Republic of Korea, as tentatively established by Saito *et al.* (1974). This study further establishes province records for this species in Jeju and Jeollanam Provinces, and demonstrates that it may be collected, especially as nymphs, from vegetation during the month of April in these provinces. Season-long surveys in these areas are warranted to better understand the questing period for the larval and adult stages, and host surveys are needed to better understand the primary and secondary host(s) of this species. It is unknown if this species is involved in disease transmission to humans or other animals.

Haemaphysalis phasiana was most commonly collected with *H. longicornis* and *H. flava*. Both of these latter species were widespread throughout the survey area, and no relationship between their presence and that of *H. phasiana* was observed. *Haemaphysalis phasiana* was collected simultaneously with *I. turdus*, but not with *I. nipponensis* or *A. testudinarium*, which were the other species collected during these surveys.

Haemaphysalis phasiana was collected in or near areas that had a marked presence of pine trees as well as dry or green grasses, other herbaceous vegetation, and a deciduous understory. Edge situations or grassy areas adjacent to pine forests also appeared to provide good habitat for *H. phasiana*. *Haemaphysalis phasiana* was collected in deeply shaded to open habitats with no discernable preference except for the close proximity of pine forests and vegetative understory.

The Saemaul Undong (New Village Movement) and the Korean government's 1973–1987 green plantation program provided the impetus to reforest Korea's mountains, which were deforested in the early 1900s and remained so until the early 1970's (Lee & Lee 2002). Pine trees, planted as part of the green plantation program, are currently 20–35 years old. Few collections of *H. phasiana* have been reported, and if pine represents the host habitat for *H. phasiana*, then one might expect that increases in maturing pine forests may correlate with an increased frequency of collections of *H. phasiana* in Korea. Since the ages of the pine forests were not measured, correlations could not be derived from this study. However, strong arguments have been made that environmental variables such as vegetative cover exert their influence chiefly on host populations, which in turn determine the species of ticks found in a given habitat (Robbins & Keirans 1992). Therefore, studies need to be made to determine what factors (specific vertebrate hosts and/or environmental characteristics) occur in pine forests that harbor populations of *H. phasiana*.

Haemaphysalis phasiana was collected at elevations of 5 to 245 m, which demonstrates its presence at low and moderate elevations. Further collections at higher elevations are needed to determine the elevation limits of this species.

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